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HOW A NATIONAL MUSEUM

OF

NATURAL HISTORY

MIGHT BE BUILT AND ARRANGED WITH ADVANTAGE.

BY

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A NATIONAL MUSEUM OF NATURAL HISTORY

MIGHT BE BUILT AND ARRANGED WITH ADVANTAGE.

Zoology and Fossils.

The author prints this Memoir and Appendix with the object of promoting, by all the means in his power, the building of a Museum which would *really* contain *all* the specimens a British Natural History Museum ought to contain. The sheet of drawings referred to (the only existing copy) is *pro tem.* in the care of Mr. W. S. Dallas, Assistant Secretary of the Geological Society, Somerset House, Geology being *par excellence* the science of all Natural History. The Memoir was written for the British Association, and an abstract of it was read to the Department of Zoology and Botany at the Brighton Meeting.

A new National Museum for Natural History is to be built on the site of the International Exhibition of 1851 at South Kensington. The length of façade is nearly 800 feet and the depth of the block above 200 feet; the main building will contain three floors of galleries, and the total cost is expected to be not far short of 350,000*l*. The site will afford room for future extension. The accommodation is said to be what has been asked for by the officers of the British Museum, but see p. 24 seq.; the building has therefore a circumference of about 2000 feet, which, multiplied by three floors, gives a length of galleries of about 6000 feet. A complete collection of Whales and Dolphins would fill all

this, and consequently the Museum will eontain nothing else of the Animal kind, and there will be no space for Botany, Mineralogy, or Fossils. A plot of 5 aeres of land near the Horticultural Gardens has lately been sold at 12,000*l.* per acre.* 44,000*l.* may therefore be taken as the present value of the land, whieh amounts to $3\frac{2}{3}$ acres.

This Memoir is written on the hypothesis that a National Museum of Natural History means a well-lighted building (having offiees without and within), sufficiently spaeious to eontain eommodiously in a suitable number of separate rooms as many speeimens as make a perfeet Museum, and so eompactly as to reduee to a minimum the distances to be walked over daily by visitors, offieers, and servants, for all time coming. This Museum would be fitted with upper galleries for the eonvenience of seeing elosely the upper parts of all the very large speeimens. When it beeame publiely known that spaces were provided, and were blank, for all speeimens whieh were still desiderata, this would be a powerful inducement in many quarters to supply the defieieneies. It would appear to be the least which can be done to provide spaees for the stuffed skins (male and female) of every speeies of the Vertebrates, and skeletons of the same, including skins and preparations. Dr. Sclater remarks, "Speeimens of both sexes and all ages" should appear, also "examples of variation." And "the skeleton and other preparations of the internal structure should be added," &e., &c. The present writer entirely coneurs in Dr. S.'s seven propositions stated on p. 128, 'Brit. Assoe. Report,' 1870, Seetions. Surely it is no ground of objeetion to the plan about to be proposed, as it will provide for all these things, that sueh a form of Museum was perhaps never proposed before The writer believes it would be very unscientific if every one was to eonsider himself bound, hand and foot for all time coming, to build no Museums exeept of the usual reetangular form (with staireases), and only two or three stories high.

* 'Builder,' quoted in 'Record,' April 8, 1872. And p. 24 *post*.

Estimate of the space required for the Cetacea.—The following are the

Lengths of some of the Largest Whales and Dolphins.

Names of the Cetacea according to the Authorities quoted.	Lengths.	Authorities.
	feet.	
Balænoptera musculus ..	64	Prof. Struthers, Brit. Assoc., 1871, Sec. p. 142.
„ boops ..	100 and more	Dr. Hartwig's 'Polar World,' 1869, p. 42.
„ Sibbaldii (average)	85*	Henry Bird, Brit. Assoc., 1870, Sec. p. 112.
Balæna mysticetus, or Greenland Whale ..	70	Lyell's 'Prin.,' vol. ii., p. 572. Peterhead, 1682.
Ditto	73	Ibid., p. 573. Airthrie, 2000 years ago.
Ditto	60	Dr. Hartwig's 'Polar World,' p. 42.
Physeter Tursio	52 or 53	Dr. J. E. Gray's 'Whales and Dolphins in Brit. Mus.,' p. 4.
Balæna australis	50	Dr. Hartwig's 'Polar World,' p. 473.
Delphinus Leucas	12 to 20	Ditto, p. 42.
Delphinus Orca, the Grampus	25	Ditto, p. 42.
Globicephalus globiceps, or Black Dolphin ..	20	Ditto, p. 42.

Dr. I. E. Gray, in his 'Synopsis of Whales and Dolphins in the British Museum,' 1868,† names and describes 104 species, of which 32 are Whales and 72 Dolphins; and at the following estimates of length, which are very moderate, we have

32 Whales, each averaging	60	feet long	1920	feet.
72 Dolphins „	15	„	1080	„
104			3000	

But these are only individual specimens. What if each species has to be represented four-fold? Namely, by male skin and skeleton and female skin and skeleton, &c. At first sight it would appear that a length of at least 12,000 feet would be required, but this can be much reduced. Dr. Gray says, however, p. 10, "The number of Cetacea will be very much extended." Of the Dolphins, a pair (male and female) can be placed side by side in the spaces of 26 feet wide which it

* Mr. Bird mentions that one was caught off Iceland in 1866, 110 feet long. It is the Steypireyör of the Icelanders, and the Rorqual of the Norwegians.

† Quaritch, 15, Piccadilly, with 38 plates, each 12 ins. by 10 ins., price 15*s*.

is proposed to provide for them, with their skeletons suspended over them; the young, preparations, &c., can be placed alongside, so that the four specimens would only occupy one length. The Whales, all but the largest, might be treated in the same manner. He says, "Sometimes only small portions of the skeletons have come under my examination," p. 10. Yet being an experienced and accomplished naturalist, by comparison of one with another, he was enabled to give a lucid synopsis of all the species which came under his notice. But what sufficed for him would not suffice for Students. There cannot be a doubt that Science would be greatly benefited by the exhibition of a complete series of specimens as aforesaid. A drawing of the skeleton within the skin of each species ought to be exhibited. A male and female of each species of the mature animals would be sufficient to supply all the specimens required (except the young); so the task is not great. The writer has no data by which to compute the total length required for the Cetacea except the lengths stated; allowing for the numbers being "very much extended," it would certainly exceed a mile; and, as aforesaid, the new Museum will afford space for nothing else. On the three-story plan, the writer believes that *all* the Natural History would require twice as much space as the Cetacea plus 1 acre = $8\frac{1}{3}$ acres, the value of which is 100,000*l.*; and $8\frac{1}{3}$ acres is an unnecessarily vast space to walk over. If a Museum of $3\frac{2}{3}$ acres costs 350,000*l.*, one of $8\frac{1}{3}$ acres will cost proportionably about 795,000*l.* Dr. Gray thinks the Museum far too small. (See Appendix, p. 24.)

Great influx of Specimens, and great numbers of Species and varieties of certain Genera and Families.—The following examples, and several others, are individually well known to naturalists, but we must recite them collectively to illustrate in some small degree the magnitude of the spaces required. Twenty thousand Natural History specimens annually come into the British Museum. "There are no less than 288 wild species of the Pigeon family (Columbidæ); yet, although some of these approach very near to others in their cha-

racters, they will not, as far as experiments have yet been tried, pair together."[a] And Sir C. Lyell also says, that in Egypt and India "more than 150 distinct races [of tame pigeons] have received names and breed true."[b] And when we consider the interesting attempts of Mr. Darwin and others to produce new species by intercrossing the breeds of domestic pigeons,[c] the space required for pigeons only will have to be sufficient for probably 500 pairs; and if male and female skins and skeletons are all to be exhibited, there must be space for 2,000 individuals. According to Lesson, there are 6,266 species of birds[d] = 25,064 specimens. Cuvier published accounts of 5,000 species of Fishes, 1828–1849,[e] and in the last twenty-two years others have been discovered; if these are to be exhibited four-fold, space will be required for more than 20,000 individuals. In Hartwig's 'Polar World,' 1869, p. 279, it is stated that no less than 14 different species of Salmon live in the Sea of Ochotsk; and Mr. A. R. Wallace mentions that 780 species of fishes have been found at Amboyna alone.[f] There are 20 species of oxen, 27 of sheep, 20 of goats, and 51 of deer;[g] of air-breathing vertebrates, 1658;[h] all to be exhibited four-fold. And there are varieties in the markings of the ass, the zebra, and the horse, &c., &c., &c.[i] That spaces ought to be reserved for all these probably no naturalist will doubt. Many species and varieties of fossil coal-plants are known; very great numbers of fragments have been collected, a series of which ought to be exhibited. In 1861, Professor Hitchcock had already enumerated in the Trias 123 species of Cheirotherium.[j] "Who would have ventured to suppose," exclaims Darwin, "that no less than at least thirty different bird-like animals, some

[a] 'Prin. Geol.' 10th edition, vol. ii., p. 305; and foot note, authority Prince Lucien Bonaparte.

[b] Ibid., p. 289.

[c] 'Origin of Species,' 6th edition, pp. 15–21.

[d] 'Testimony of the Rocks,' p. 326.

[e] This reference is missing.

[f] 'Malay Archipelago,' 3rd edition, p. 301.

[g] 'Testimony of the Rocks,' p. 329, and Johnston's 'Physical Atlas,' 1856.

[h] 'Testimony of the Rocks,' p. 326.

[i] 'Origin of Species,' pp. 127–9.

[j] Page's 'Advanced Text-Book of Geology,' p. 239.

of them of gigantic size," existed during the Miocene period?[k] In the Red Sea alone, according to Ehrenberg, 120 kinds of coral have been observed.[l] The heights of the various circuits of the Animal Galleries are exhibited on the sheet of drawings; they ought to be fixed in consultation with the Keepers of the Collection. In a future paragraph (p. 14), a method of providing height enough for gigantically tall animals, such as the Giraffe, Mastodon, and Dinornis, will be described, still leaving the animals in their proper places in scientific order, and without altering the plan at present laid down. The remains (nearly every bone) of a Mastodon giganteus were discovered in 1866 at Cohoes, New York, in a post-tertiary deposit of peat and marl. The tusks were estimated to be 12 feet in length before they were disturbed or broken. The height of the skeleton is judged to have been 15 feet, and its length 17 or 18 feet; it had six teeth, the largest of which weighed $5\frac{1}{2}$ lbs.[m] More than 30 distinct species of this and other proboscidians collected by M. Gaudry are (or were) chronologically arranged in the Paris Museum.[n] There are five (? six) living and fifteen extinct species of Rhinoceros.[o] All these ought to appear in the Museum, that is to say, spaces ought to be provided for them, which would increase the chances of their coming some time. If we will not provide for all this, the National Collections will be Poor, not Rich.

Some particulars of the proposed Museum.—Let us inquire whether a change of plan might not relieve us of the fatigue of walking over 8 or 9 acres; namely, by altering the forms of future Museums, and by calling in the aid of the steam-engine and other mechanical appliances. Every small manu-

[k] 'Origin of Species,' p. 284.

[l] 'Ehrenberg über die Natur,' &c., &c., p. 46.

[m] Hardwicke's 'Science Gossip,' May 1, 1872, p. 114. See also two Photographs of this Mastodon, rock excavation, &c., presented to the Royal Society, by John V. L. Pruyn, Esq., as mentioned in 'Pro. Roy. Soc.,' No. 135, p. 376.

[n] Lyell's 'Principles,' vol. ii., p. 482–3.

[o] Ibid. There are *six* living species, including Dr. Sclater's R. lasiotis. See Brighton Meeting, Brit. Assoc.

factory has its steam-engine and machinery, and why not the most important Museum in the world? A rectangular space measuring 800 feet by 200 feet contains $3\frac{2}{3}$ acres, and a square measuring 400 feet on each of its four sides contains an equal area. In the centre of this square draw a circle of 344 feet diameter, and this will represent the outside of the Museum now proposed, which will contain 2·1336 acres; the remaining space within the square will be occupied by various auxiliary offices, &c. This Museum is to be carried up to the height of 160 feet, and will consist of 12 floors, any one of which can be reached noiselessly, up or down, in a few seconds by the Hydraulic Hoist, at the cost of $\frac{1}{2}d.$ or $\frac{1}{2}d.$ post stamp. The writer is well aware, however, that these views, as far as they are new, must be allowed the usual amount of time before they can operate. Novelties are at first often unpopular. Before the writer knew that the site of the International Exhibition of 1851 had been selected for the Museum, he had mentally fixed upon a site of his own, and had made great progress in drawing up this Memoir, and preparing illustrations in conformity, and therefore found it best to proceed with what he had in hand. But any other site would do as well where two adjoining sides of the square were bounded by roads, if no lofty buildings could be erected too near so as to intercept the light. The site mentally fixed on is shown by *Fig.* 1. The Porch on the east side is $\frac{1}{4}$ mile south of the Kensington Road, and the square of 400 feet is at the angle formed by Prince Albert Road with Gore Road, at the south side of the latter. Dr. J. E. Gray's practical experience in the management of Natural History collections has induced him to believe they would be best in the centre of London. The writer therefore considered the practicability of erecting the proposed Museum on the south-western angle of the British Museum estate, both to meet Dr. Gray's views and to save the 44,000*l.*; but is compelled to abandon the idea because it would make so much havoc with the present buildings. And besides, the Library contains at present upwards of a million volumes, and is said to double itself in

fifteen years; and therefore much more space will soon be required for books. In truth, it would appear that if the Museum which is the subject of this Memoir was built, and if the specimens of Art and Curiosity were transferred to the Museum which Government intends to build, the British Museum might then be entirely devoted to the purposes of a Library; thus the various collections would probably have space enough, but not too much. It would make sad confusion if the Government Museum now about to be built were to be fitted up for Natural History, and had afterwards to be altered to receive the Arts and Curiosities. To recur to the site on the south of the Kensington Road.

The Entrance would be from Prince Albert Road, by a Porch 20 feet square and 20 feet high to the ridge, lighted by a glass roof. Right and left in this porch would be Cases faced with plate glass, and containing on brackets marble busts of the most eminent Naturalists both dead and living. The Hall would be 20 feet wide and 20 feet high from the porch to the Hoist in the centre of the Museum.

The Museum.—The porch leads through spring-doors into the Museum, a circular building 344 feet outside diameter, faced on its exterior with vermilion-coloured bricks, relieved however of its factory-like look by means of stone heads and sills to the numerous windows, *Fig.* 6. By small and inexpensive variations of the mouldings of the corbels, and by sometimes introducing jambs, considerable variety might be obtained, which would add to the interest of the building's exterior. To give good light into the Museum, there would be 880 windows, all glazed with *non-transparent* glass (called by the manufacturers 'rough cast plate glass'), to avoid distracting the attention of visitors from the Natural History specimens. There would be an ornamental stone cornice at the eaves, see left-hand part of *Fig.* 7. The building would be in the Italian style, to suit the moderate pitch of the roof. Except 12 feet at the eaves, which would be of corrugated iron, the roof would be of non-transparent glass, and carried by a wrought-iron tension frame-work supporting cast-iron ribs

and rafters. All the *solar* light which was possible on this plan has been got by the numerous windows and roof; any deficiency could be supplied by gas. The radiating cast-iron rafters on which the glass would rest would communicate with the lead eaves gutter, which again would be in connection with twelve cast-iron down-spouts, *Fig.* 6; all these spouts would be continued into the ground. The top of the building finishes by a hollow tapering cast-iron flagstaff, which would fit into a socket in the frame-work, from which there would be, as described, a continuous line of metal to the ground outside, and so the building would be lightning-proof. St. Paul's is protected in this manner, and it never receives any damage. No other materials would be used for the building and its fittings than stone, brick, mortar, iron, and other metals, glass, and kamptulicon floor matting. The building would therefore be fire-proof.

Circular iron Curb for the top of the Outer Wall.—The outer wall, 4 feet thick and 160 feet high above the ground floor, would carry on the centre of its top an iron curb, cast in segments of a circle, all of which would be bolted together. The curb would have recesses to receive the rafters, to which the latter would be bolted; this curb is intended to bond the top of the wall, and to take off the thrust of the rafters ends. Within the outer wall, at the distance of 48 feet in the clear, would be a second circular wall, containing numerous glass doors, and many useful cupboards for the Work-rooms. And there would be other openings communicating with the Gallery of Animals. This wall would also be 4 feet thick and 160 feet high; there would be a series of equidistant York landings, each 4 feet long, 2 feet wide, and 6 inches thick (corresponding in number with the number of the rafters), bedded on the top of the wall. On each landing would rest the proper part of the tension frame-work, supporting two radiating spurs; this arrangement would shorten the bearing of the roof—it would be premature to give working drawings of this roof. Both the walls would have long strips of hoop-iron built in between the courses of brickwork in sufficient

numbers longitudinally and across, wherever not interrupted by doors, cupboards, or windows. The strips would add considerably to the stability of the structure.

Economy and dignity of appearance have been considered.—It will have been observed that the whole building is as plain and as little expensive as is consistent with decency and safety from fire. The writer's object is *that the needful should be done and no more.* The Museum as drawn is about 220 feet high to the apex of the roof, being 18 feet more than the height of the city Monument. And the staff carrying the Royal Standard is 30 feet more. Total height 250 feet. The magnitude of these and of the other dimensions would necessarily impress the mind. And it would be easy, by means well known to engineers, to lift up the roof gradually, and build underneath it, say three more stories. But it would be best to carry the building to the required height at first.

The Gallery of Animals.—Passing through the Porch into the Museum, on your right would be the commencement of the Inclined floor of this Gallery. It runs round and round the building like a corkscrew; first by a gradual ascent of 1 in 47, afterwards diminishing to 1 in 94; in 12 circuits it lands you at the top of the building. There are only 11 heights of windows on the drawing, because the 12th circuit is lighted from the roof. The path of this gallery would be 12 feet wide, and well lighted by 880 non-transparent glass windows on the right. In each of these would stand a horizontal case, covered with plate glass, 3 feet wide and averaging 6 feet long. These cases are intended mainly for the Invertebrata. On the left hand would commence the Cetacea. These being such immense creatures, and of so many species (we have seen that there are already known 32 whales and 72 dolphins, and that the number will be "very much extended"), will necessarily require a very large space for their complete and convenient arrangement. Some particulars will now be given as to the spaces likely to be required for the Cetacea. The diameter of the circle con-

tained within the path of 12 feet is 312 feet, and its circumference therefore is 980 feet, which multiplied by 5 circuits and adding 1356 feet contained in the Cetacea Room (to be described presently) gives a total length of 6,256 feet for the Whales and Dolphins; known and unknown. The Spaces proposed for their exhibition are 20 feet high and 26 feet wide on the first circuit of the building, gradually diminishing to 12 feet high on the 5th circuit. There would be a path 10 feet wide at the back of the Spaces, adjoining the Inner wall. Brass railings, resting on iron standards, would inclose these Spaces, and *there would be no glass, except a partition of non-transparent glass between each two species. These partitions would occupy very small spaces, because the frames, being of iron, would only be* 2 *inches thick and the glass* $\frac{1}{4}$ *inch. This arrangement would be equivalent to exhibiting each species of Cetacean in a separate Room, and would therefore confine the attention of visitors to one species at a time, which could not possibly dwarf the apparent size of the specimens.* This is especially the case on the present Plan, because owing to the curvature of the Gallery, if you stand in the centre of it, you can only see about 45 feet on either side along the Gallery, although you can see all over the space occupied by the one species opposite you. A suite of specimens of the Balænoptera boops, 100 feet long, would require a space 400 feet long to exhibit them properly, *viz.* male skin and skeleton and female skin and skeleton; the young and preparations could be placed alongside and would require no extra length. The smaller species could be arranged, as already described on pp. 5, 6. Standing at the centre of the B. boops compartment, the curve will allow of your seeing 200 feet in either direction, right or left, and you could see opposite you all the way to the inner wall. The floor of the Gallery would be carried on cast-iron girders, of which the ends would be built into the Inner and Outer walls. See *Figs.* 9, 10. The writer has often used girders of this shape in building Railway bridges. The strongest form is known to be, when the bottom flange has about six times the sectional area of the

top flange. In the present case about 10 inches deep would be sufficient, as each girder is supported in two places by iron columns. These girders can be altered as often as required, and very easily; for a certain important purpose, *viz.* when specimens of the Giraffe, Mastodon, or Dinornis, or the tall arboreal fossils of the Oolite or Coal have to be accommodated. The centre part of the girder, from column to column, 18 feet long, can be omitted in casting, to allow the upper parts of the specimens to ascend through the floors above. In such cases the plate-glass fronts may also be omitted, and the upper floor can be reached by a light iron stair. Thus all these tall animals and plants will appear each in its proper place in scientific order, and each can be completely examined. On the bottom flanges of the girders would rest iron gratings, their tops coinciding with the respective tops of the two girders on which they rest, so as to form the regular sloping floor, which would be covered with kamptulicon, like the floor of the Reading Room of the British Museum. *Parallel pairs of iron bars, resting on the bottom flanges, and extending from girder to girder, would be very useful to suspend skeletons from (particularly of the Cetacea), and from other bars would also be suspended the Upper Galleries;* this arrangement would not interfere with the 12-foot path beneath. The girders and gratings would be tastefully coloured underneath, and they would be seen overhead, as there would be no lath and plaster ceilings below them. The window cases would be a mile in length by a yard in width, and there might be seats, each consisting of a bench 5 feet long, between the windows. Supposing there were only two on each bench, 1760 persons might be seated at once. But this large supply of seats requires caution, lest the Museum be made a lounging place.

Inclined Planes preferable to Staircases.—The proposed Museum would contain as few staircases as possible because they take up much space, and inclined planes are more consistent with Nature. *Natura non facit saltus.* The Central Galleries for Mineralogy would however have horizontal

floors, because their small diameters would cause an inclined plane to be too steep. Each floor would communicate with the next above by iron stairs, and also by the Hoist. The floors of the Porch, of the Cetacea Room, and the ground floor of the Museum, would all be on one and the same level; namely, one foot above the footpath of Prince Albert Road, which foot would be surmounted by two steps at the outer door of the Porch. It will be convenient now to describe the Cetacea Room, and next the Store Room for spare specimens, and then to continue the account of the order of arrangement of specimens in the Animal Gallery.

Cetacea Room.—Passing again through the Porch into the interior, to the left is a door opening into this room, which is provided for as many as it will contain of certain Families, Sub-orders, or Tribes of Cetacea, selected and arranged according to the Keeper's judgment. On this door might be painted the words 'Cetacea Room,' and beneath, the names of the species in the Room may also be painted. This room occupies the whole width between the Outer and Inner walls, namely, 48 feet, and its average length is 678 feet. It would be subdivided by partitions of non-transparent glass and would have a path along the centre; total length of space obtained 1356 feet. It has a level floor 2 feet below the bottoms of the windows, some of which appear on the left hand part of *Fig.* 7, between the letters A B. Its ceiling is an inclined plane, being parallel to the inclined floor of the animal Gallery above; it is 20 feet high at the door, but when you have gone $\frac{3}{4}$ round the circle, its height will have diminished to 5 feet. To avoid wearying visitors with the sight of so many Cetacea, none need enter this room except those who wished to see its contents.

Store Room for spare Specimens.—It is proposed to continue the circle of the Cetacea Room for an average length of 160 feet or more towards the Porch. This room or cellar would be partly underground, and would be lighted partly by windows and partly by gas. The floor and ceiling would slope down at the rate of 1 in 47 as you advance from west to

east. The width of the room would be 48 feet and its height 9 feet. It would serve as a store for spare duplicate specimens until they were exchanged with other Museums, given away, or sold.

Order of Arrangement of the Specimens.—This is evidently a matter of the utmost importance. It is proposed to leave it to the officers of the British Museum, subject to the arrangement of cetacea already proposed on pp. 13, 15, which arises from necessity. Some of the upper circuits would be each 9 ft. high, and the Cases, when the specimens were small, would only be 8 ft. high ; both because the upper foot would not be well lighted, and because it is desirable to keep small specimens near the level of the eye. Behind all the Vertical glass Cases would be the Work-rooms, according to Dr. Sclater's excellent idea (Brit. Assoc. Report, 1870, Sec. p. 126), extending back to the Inner wall. These rooms would be lighted by the outside windows, and gas might be used when necessary. The writer is under the necessity of naming something (which must go for what it is worth) about the arrangement of the remaining Vertebrata, else he could not explain his plan intelligibly ; and he proposes to go on with the Historic Animals next after the Cetacea. Every Family of Vertebrates would be separated each from the next by a partition of non-transparent glass. The plan of arrangement is the Cuvierian, subject to certain modifications proposed by Professors Owen, Huxley, and others.

(1) *Plate-glass Case containing the Bimana.*—This Case would in time, as presents and purchases came in, become rich enough in specimens to satisfy and gratify Anatomists, Anthropologists, Antiquaries, Derivationists, Ethnologists, Evolutionists, and Naturalists, and Osteologists in general. The savage peoples might have their dress, arms, and implements, if of their own manufacture; care being taken that these utensils should not be the products of the ingenious artizans of Birmingham or Sheffield ; and that the stone or flint hatchets, arrow-heads, and the like, should not be the

manufactures of the late "Flint Jack," or of his Irish successor.

Cases (2) *to* (11) *inclusive.*—These plate-glass Cases would contain respectively the Quadrumana and Cuvier's quadrupeds in *his* order, subject to any modifications as aforesaid. These Placentals would be followed by the Aplacentals. Then would come Cuvier's eight Families of Birds, subject to modifications if any are well established. If the eggs and nests appeared in the window cases opposite, they would be in a better light. Then would follow in order the Reptiles Proper, next the Batrachians, and lastly the Fishes, which complete the Historic Vertebrata. All these Vertebrata to have skeletons, male and female, placed conveniently near their respective stuffed skins: also sectional drawings, showing in each instance the position of the skeleton within the skin.

Fossil Animals and Plants.—Next after the Historic animals would come the Prehistoric, and then the rest of the Tertiary fossils in order; next the Secondary, and lastly the Primary. A space should be left between the Lower Eocene and Chalk, and another space between the Lower Trias and the Magnesian Limestone, to show that there are, at present, two series of Fossils missing. Thus it will be observed that, as you ascend in height you are ascending in Geological time. Those who wished to see the Fossils in the usual order, namely, the oldest first, would always have the option of ascending by the Hoist to the top to begin; and then they would have the advantage of walking down instead of up the gently sloping floor. There would be a partition of non-transparent glass between each two Formations, if thought advisable, which may, perhaps, be a question, since there is no hard and fast line between any one formation and the next. The various Formations ought, however, to have their respective names conspicuously painted. The fossils of the Silurian, Cambrian, and Laurentian, not being vertebrates, would appear in the window Cases, the Silurian commencing opposite the end of the Old Red. In all cases the fossil ver-

tebrata ought to be placed opposite the fossil invertebrata respectively of the same age.

The Work-rooms would contain all the specimens reserved for private study. These could be inspected by students having the entrée on (say) five days per week, and the public could examine the public parts of their Museum, within certain hours to be fixed, during the same five days. Darwin says most justly :—"The noble science of Geology loses glory from the extreme imperfection of the record." Ought we not all to do our best towards perfecting the record? And is it not the *first* step to provide a place of deposit, of *any* form which may be most generally approved, suitable and sufficient in all respects? All the Vertebrates except the Cetacea and very gigantic animals would stand on Trucks with wheels, so that they could be drawn back and moved without the specimens being disarranged, from their present places to others more suitable. The total length of the twelve Circuits and Spaces provided for the Vertebrata, measured along the inside of the 12-foot path, and including the Cetacea room, would be $2\frac{1}{2}$ miles less 84 feet. The trucks could not be seen by visitors.

A Circular Museum requires fewer Materials, and is more compact than a Square of equal area.—A Circular form on plan has been chosen, because it is well known that a circle contains a greater area within a given length of circumference than a rectangle, and consequently it also requires a smaller quantity of materials and is more compact. *Ex. gr.*

1. Diameter of the Circular Museum inside the Outer wall	lineal feet	336
2. Its circumference, omitting fractions of a foot	„	1,055
3. Total length of four sides of a square of equal area	„	1,191
4. Being a less length of wall and window required for the circle	„	136
5. Area of wall and window saved by Circle from floor to eaves	superficial feet	21,760
6. Saving by Circle in a wall 4 feet thick would be	cubic feet	87,040
7. Content to the Eaves of the Circular Museum	„	14,186,180

The 4th, 5th, and 6th items refer to the Outer wall only; there would be similar savings though not so large, in respect of the Inner wall. There would be savings also in ground, girders, gratings, railings, painting, plastering, and roof. This compactness is a point of great importance; because all the millions of spectators who visit the Museum, as well as the officers and servants, will have to walk over the Galleries daily for all time coming; and the distances therefore ought to be reduced as much as possible.

The Botanical Gallery.

This, with the Lecture Rooms and Library, would occupy the whole of the inclined plane between the Inner wall and the path near the centre, *Fig.* 2, and would have twelve circuits of floors. The blue lines on the right of the path ought not to have been drawn as circles. They ought to have been drawn thus:—Commencing on the east, the edge of the Gallery ought to recede to the right gradually to the amount of 2 feet in each circuit for every 10 feet in height, all the way to the top of the building. The edge of this Gallery would be protected by an iron railing everywhere, of which a specimen appears in *Fig.* 3, with a note thereupon. Immediately within this railing would be plate-glass Cases containing the Botanical specimens, which would be well lighted from the roof. If thought desirable openings could be left through all the floors to receive the bark of a *Wellingtonia gigantea*, like that which was unfortunately destroyed by fire at the Sydenham Palace. The whole of the bark might be shown in two lengths, provided the whole height of the tree did not exceed 400 feet. An entire example of the Kelp or *Macrocystis pyrifera* might also be exhibited. The stem is sometimes 360 feet long, its root adhering to stones (Darwin's Journal, 1870, p. 239). The stone might rest on the ground floor, and the upper part of the stem could be bent over one of the tension rods of the roof, and hang down. Other gigantic plants could be well exhibited. In these respects

the great height of the building is an advantage. The net area of these floors, after deducting 48 paths, each 10 feet wide, would be about 57,000 superficial feet, much of which would be surplus space at first. There would be plenty of seats.

The Mineral Galleries.

These would occupy the whole centre of the building except the Hoist, and the floors would be twelve in number, each absolutely level. Access might be attained to each floor in succession in two ways, *first* by iron stairs from the ground to the first floor, and so by other stairs to other floors in succession. And *second* by the Hoist, of which more presently. On the ground floor there might be a complete series of the igneous rocks; the Basalts and Columnar Porphyries being built up of their characteristic columns. Large specimens might be exhibited, as they would rest on the solid ground, and the height to the floor above would be 20 feet. A series of lavas, sulphurs, &c., might come next. Then travelled boulders; perched, angular, rounded, and scratched. Next building stones and slates of all species, in the natural states, and worked. Next the various species of Coal and Lignites. Afterwards the Chalk and Flints, and then the Metallic Ores (which would require glass Cases, the previous Minerals not requiring protection), refined specimens of each metal would accompany its Ore. Then the many species of dead Coral rock; then the precious stones, cut and uncut; and lastly the Meteorites. The floors of the Mineralogical, Botanical, and Animal Galleries would on each floor be on one and the same level at the respective Bridges, *Fig.* 7. The Mineral and Botanical Galleries would be carried on iron girders, supported as often as required on ornamented hollow iron columns; the floors would be fitted and completed like those of the Animal Gallery, described on p. 14. The Mineral Galleries would be protected at their edges by iron railings, see *Fig.* 3; they would have an area of upwards of 50,000

superficial feet, which is more than an acre, much of which would be surplus spaee at first.

Specimens to be all labelled.—It cannot be too much insisted on that every specimen ought to be labelled, both with its scientific name for the benefit of the learned, and with its English name for the benefit of the unlearned; because the British Museum in all its departments is said to eost the public 110,000*l.* per annum, and it ought to be a school for them.

The Hydraulic Hoist, &c.

This Hoist, eircular on plan, and 20 feet in diameter, would have an area of 314 superficial feet, whieh, allowing 4 feet to each person, would accommodate 78 persons at a time, standing, on busy days. The Hoist would run on three equidistant iron bars the whole height of the building, and for safety there would be an iron railing (with gates) all round. In case of the lifting power being suddenly withdrawn by any accident, the Hoist would not fall to the bottom, because of self-acting springs called technically 'friction clutches,' which would, whenever the velocity of descent exceeded a certain fixed amount, firmly grasp the bars and stop the descent entirely. As already stated, visitors would be earried up or down noiselessly by the Hoist, to any floor, at the cost of $\frac{1}{2}d.$ or $\frac{1}{2}d.$ post stamp, in a few seconds. The moving power would be Hydraulic, worked by one of the two small steam-engines in the grounds, which would also pump water into a large eistern at the top of the building for cleansing and drinking, if none of the Waterworks Companies which have mains near, could deliver a supply at the required height. The cold water would be conveyed by an iron pipe, see *Fig.* 5, through the whole of the Gallery of Animals, and there would be taps and drinking vessels in every circuit. The boilers would supply hot water, which would cireulate about and warm the building (as it does in every hothouse) through another pipe, *Fig.* 5. The object of having two engines is, that one may

do the work while the other is being repaired. The Hoist would be at the disposal of the officers when visitors were not present. Some non-conducting substance would be interposed between the tops of the bars on which the Hoist works and the ironwork of the roof, to prevent lightning from being conducted down to the floor of the Museum.

The Buildings, &c., in the grounds.—The uses of some of these are explained in the Drawings, and partly in the last paragraph. The buildings are Refreshment rooms three stories high and 60 feet square, flanked by two sets of offices each 20 by 40 feet. Porter's Lodge, 30 feet square, with small garden. Resident Naturalist's house, 40 feet square and three stories high, with garden. Two 10-horse engines, boilers, hydraulic apparatus, and engineman's house, 100 feet by 40 feet. Reservoir of condensing water, gravel walks, and lawns. Two sheds, one 90 feet by 17 feet, the other 70 feet by 20 feet, for unpacking rooms, both lighted by skylights. Thus we have seen much may be done on $3\frac{2}{3}$ acres.

Space.—The writer has no misgivings whatever in the direction of having provided too much space. All his apprehensions run in the direction of providing too little. So far as at present advised, he thinks the main building herein proposed ought to be carried up higher than twelve stories, because it is the nature of Museums to be perpetually increasing their contents, for all time coming. A great accession of Marine Natural History may fairly be expected from the intended three years' Government expedition for deep dredging in the Great Oceans, as well as from Livingstone's country, Lakes and Land, in Africa. He does not presume to suppose that some others of these many details could not be altered with advantage, on further consideration. All he means is, that this Memoir is as good as he could make it with his present lights. A week's work in a Museum so completely furnished with specimens as this, would indeed be a treat.

The intended Government Museum of $3\frac{2}{3}$ acres multiplied by its three floors gives 11 acres. The Museum proposed by

this Memoir covers only 2·1336 acres, yet when multiplied by its 12 floors we have the large area of 25·6 acres, being 14·6 acres in its favour. The former is only 43 per cent. of the latter Museum's area.

Estimates.—The expense of the twelve-story Museum and its appendages, worked out in detail at the prices current in April, 1872, would be 354,788*l.*, which includes 6,471*l.* for kamptulicon floor cloths, seats, tables, and desks; but it includes nothing for the $3\frac{2}{3}$ acres of land. The present disorganized state of the building operatives, and the almost fabulous increase of price of building materials, would necessarily increase the cost of either Museum. Each of the two estimates made in the early part of this year amounts to about 350,000*l.* This, then, is the fair inference:—

The Nation can have for a given sum either (1) a Museum which will only hold the Whales and Dolphins, or (2) a Museum which will hold all the Zoology, Botany, Mineralogy, and Fossils, in a very compact manner and easy of access.

The author of this Memoir will always have great satisfaction in reflecting that he has done his best to promote the building of a Museum which would really hold *all* the Natural History specimens. To make a British Natural History Museum what it ought to be, it must contain such a prodigious number of specimens as defy human ability to accommodate them conveniently, except on the principles herein recommended.

If the twelve-story Museum is to be built, immediate action is necessary; perhaps by an influential deputation waiting on Her Majesty's Government to explain the facts. Government is known to be favourable to judicious economy.

APPENDIX.

Extract from 'The Times,' July 6, 1872.—H.M.'s Government purchased from the Commissioners of the Exhibition of 1851, for 120,000*l.*, land, of which the value is not less than 280,000*l.*, to be applied to Science and Art. 'A district post-office has been erected upon it,' Mr. Bowring loquitur. Lord Elcho said, 'the Contract [for the Natural History Museum] was not taken a fortnight ago.' Mr. Ayrton said Captain Fowkes' Design was successful, it was to cost 430,000*l.* When he died Mr. Waterhouse was employed, who is preparing working drawings. Government fixed the cost at 350,000*l.* This debate arose in the House of Commons, on the question of voting 40,000*l.* towards the expense of the new Museum, which was carried.

The following are copies of three letters received by the present writer from Dr. I. E. Gray, whose long experience as keeper of the Zoological collections of the British Museum, makes his opinions valuable. In consequence the preceding Memoir has been re-written, adopting his suggestions, which was easily done. His objections were easily removed by removing the causes of them. If the Arts and Curiosities were transferred to the Museum now about to be contracted for, as Dr. Gray proposes, there would then be room perhaps at the British Museum to exhibit the Natural History collections, including the unexhibited portions, a little longer, namely, until the Library requires greater space :—

British Museum, April 2nd, 1872.

Dear Sir,—Thanks for your kind offer to show me your drawings of what you think requisite for a Natural History Museum.

The space proposed is very small, not more than we have at present, and there is a great want of room for the unexhibited portion of the collection, not nearly as much as we have here.

I should have no objection to see your papers and drawings, but

I believe that it is too late for any alterations to be made; indeed I am an advocate for the collection remaining where it is, in the middle of the town and near to the class of persons that study Natural History, and therefore use the collection; and I hope that before it is built the artists and others who are encouraged by the rich and people of leisure living in the west of London will see the advantage of having the new Museum applied to their purpose, for which it is fully as well suited as for Natural History.

I am, &c.,

(Signed) I. E. Gray.

P.S.—I ought to say that the new Museum meets with the approval of several of the leading scientific men, who urge its adoption by the Government, and that I am nearly alone in my opinion.

R. A. Peacock, Esq.

British Museum, April 9th, 1872.

Dear Sir,—I wrote my letter to you with no intention of its being shown, but I have no objection to its being shown to Captain Douglas Galton, or any other person whom you may think fit. I have expressed nearly the same ideas in my reports and other writings.

Your papers and drawings have not yet arrived, and I will return them to you very shortly. My internal local complaint prevents my leaving the Museum or attending any meetings of societies, &c., as I formerly did.

Yours, &c.,

(Signed) I. E. Gray.

British Museum, April 10th, 1872.

Dear Sir,—Your paper and the plan arrived this morning. The plan is very interesting, but I must say that I have not been able to give it much study; indeed, not as much as it would require to be properly understood. It is very different from any Museum that has previously been built, and I suppose old habits have induced me to believe that separate rooms of a moderate size, with

a few large galleries* on the upper floor for the gigantic cetacea and large fossils are best adapted for a Museum. My friend, Mr. Fergusson, gave a curious plan for a Museum, but it was never adopted.

I believe the foundation of the Museum at Kensington has been dug and contracts made for the execution,† so that I expect we may consider that determined upon.

There is one very great objection to very gigantic rooms,* they dwarf and deteriorate the importance of specimens.

I have always advocated the Natural History Museum being in the centre of London as now placed, because the study of Natural History is chiefly followed by the middle and lower classes of the population; on the other hand, I have always advocated the Museum of sculpture, pictures, and other objects of art and curiosity, being at the west end of London, because they are only collected by the rich people who have leisure, money, and room at their disposal, and live in that part of the town.

Yours truly,

(Signed) I. E. Gray.

P.S.—I have returned the plan and paper by the post of this day.

An abstract of the preceding Memoir was read at the Brighton Meeting, to the Department of Zoology and Botany, and the following notice of it appears in the 'Athenæum,' p. 275:—

A paper was read which had been sent by Mr. R. A. Peacock, 'On Natural History Museums.'—The author stated that the 6,000 feet of gallery space in the New Natural History Museum would serve no more than to accommodate a complete collection of the known species of whales and dolphins. He described a plan of a circular museum with twelve stories, and two miles of wall-cases and spaces, which would adequately contain the collections he thought should be displayed.—In the discussion that ensued,

* The separate rooms are now provided, and they are no longer gigantic, being divided by partitions. The upper galleries are also now provided. See pp. 13, 14, *ante*, the parts printed in italics.—R. A. P.

† The contracts had not been let in the last week of June, and they can hardly have been let since, building is at a standstill.—R. A. P.

the opinion seemed to be generally assented to, that the same collections would hardly serve the double end of public display and scientific study. For the last purpose, for example, mounted birds were altogether unfit. Local museums should try to relieve the demands on the time of the keepers of the national collection by getting accurately-named series of local objects of natural history. The loan of specimens was also discussed, and Mr. Bentham expressed the opinion that from his experience, though science might be benefited by it, on the whole it was very likely to be prejudiced in consequence of their more or less certain injury or loss.

Note by the Author.—The Work-rooms, as stated on p. 18, would contain all the specimens reserved for private study, such as skins, preparations, and the like. These rooms would be at the back of all the Cases containing the Historic and Fossil Vertebrates, they would be upwards of 20 feet wide, and would form seven circuits round the Museum of 980 feet each, total 6,860 feet, suitably divided into separate rooms. This vast amount of space it is hoped satisfactorily solves the problem in the affirmative, 'that the collections in the twelve-story Museum would serve the double end of public display and scientific study.' It is quite clear there would be ample-space for *both* series of specimens. It has already been stated that all the Vertebrate specimens except the Cetacea, Giraffes, the Mastodon, and the Dinornis, would stand on Trucks with wheels. One or more of these Trucks could be drawn back from the plate-glass fronts, to admit students to a good light when examining skins, &c. Or by opening doors in the glass front, access could be gained with specimens to the outside windows themselves, where the light would be the best possible. Plants and Mineralogical specimens could be equally well examined, by bringing them to the fronts of their respective Galleries.

12, Queen's Road, Jersey,
Sept. 25, 1872.

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